Abstract Title Page
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Title:

Preparing Prekindergartners with Math Readiness Skills: The Effect of Children's Talk, Focus, and Engagement on Math Achievement

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Abstract Body

Limit 5 pages single spaced.

Background/context:

Description of prior research and/or its intellectual context and/or its policy context.

Well-designed and well-implemented model prekindergarten programs have shown the potential to improve children's cognitive growth, readiness-for-school, and the likelihood of long-term outcomes such as persistence in school and higher rates of graduation. Such effects have been reported for the Perry Preschool Project (Schweinhart, Barnes, Weikart, Barnett, & Epstein, 1993), the Abecedarian program (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002), and the Infant Health and Development Project (McCarton, Brooks-Gunn, Wallace, & Bauer, 1997). However, in a descriptive review of such model programs as well as large-scale public programs that generally have less funding and serve children from low-income homes, it was reported that public programs had much weaker effects than the model programs according to existing literature (Barnett, 1995, 1998). Thus, researchers concerned with the early childhood education of children from impoverished backgrounds seek to identify interventions that will more effectively produce the positive outcomes seen from earlier model prekindergarten programs.

One particular area of concern is math achievement. Children who fall behind in math during elementary school are far more likely to spend the remainder of their K-12 career trying to catch up, and a disproportionate number of these students are from poor or minority populations (Ball, Goffney, & Bass, 2005). While the field of early childhood education has identified and communicated strategies to improve reading-readiness, less is known about successful strategies for improving math-readiness. Early math skills have been found to predict both later math and later reading abilities, while early reading skills predict only later reading ability; furthermore, early math skills were better predictors than early reading skills of later reading ability (Duncan et al., 2007). To improve math education overall, and especially for those from impoverished backgrounds, a greater emphasis should be placed on identifying successful strategies and interventions that prepare children in large-scale public programs to begin school ready to excel in mathematics.

Purpose/objective/research question/focus of study:

Description of what the research focused on and why.

The *Building Blocks PreK Math Curriculum* (Clements & Sarama, 2007) was designed to facilitate children's engagement in math and talk about math. Much research investigates the effect of curriculum on classrooms or teacher practices. This study used a mediational model to look at a curriculum's effect on children's achievement gain, operating through specific child behaviors in the classroom. Specifically, this study looked at how a math curriculum affected children's focus in math alone or in all learning activities (math, literacy, science, social-studies, and other), talking during math-related activities or in all learning activities, and engagement during math or during all learning activities. Additionally, this study examined how those child behaviors predicted children's math achievement gain. It is hypothesized in the existing literature that much of the variability in student achievement across prekindergarten programs can be explained by the amount of time children are engaged in learning through talking,

listening, or sustained focus on academic content. Behaviors like a child's focus on instruction (Barr & Dreeben, 1983; NCES, 2002), verbal behaviors (Winsler & Naglieri, 2003; Dickinson & Tabors, 2001; Snow, Burns, & Griffin, 1998), and educational engagement (Brophy & Good, 1986; Howse, Lange, Farran, & Boyles, 2002) are all considered critical elements of learning. This study was based on the hypothesis that a curriculum which encourages teachers to focus on such critical elements in the classroom can lead to changes in child achievement if changes in children's behaviors are also affected.

Setting:
Specific description of where the research took place.

This study was conducted as part of the SUNY Buffalo/Vanderbilt scale-up of the *Building Blocks Prekindergarten Math Curriculum* in Nashville, Tennessee. Fifty-seven classrooms from twenty sites, 16 Public Schools and 4 Head Start centers, participated in one of two study conditions. Thirty-one classrooms participated in the new math curriculum while twenty-six classrooms conducted business as usual. Across both conditions, children were observed in their classrooms and during mealtimes on three typical days - once in fall, once in winter, and once in spring, - but not when they were outdoors.

Population/Participants/Subjects:
Description of participants in the study: who (or what) how many, key features (or characteristics).

The final analytic sample is comprised of 565 children with both pre and post test scores on at least one of two standardized math achievement measures and at least one of three classroom observations. Children who were listed by their teachers as being English Language Learners or having Individualized Education Plans were excluded from this analysis. The sample was 58% female, 87% Black, with mean age of 4.5 years at date of pretest. One of the qualifications to enroll in the included programs was eligibility for the Free and Reduced Lunch Program, so all children were from low-income households.

Intervention/Program/Practice:
Specific description of the intervention, including what it was, how it was administered, and its duration.

Building Blocks Prekindergarten Math Curriculum is a supplemental mathematics curriculum designed to develop preschool children's early mathematical knowledge through various individual and small- and large-group activities. It uses *Building Blocks* software, manipulatives, and print material. The curriculum embeds mathematical learning in children's daily activities, ranging from designated math activities to circle and story time, with the goal of helping children relate their informal math knowledge to more formal mathematical concepts. A basic tenet of *Building Blocks Prekindergarten Math Curriculum* is that children who talk more about the math they are doing will learn more math. Teachers are encouraged to probe children's understanding with higher-order inferential questions and allow sufficient wait time for children to answer. Thus, it is anticipated that children in the treatment condition will spend more time on math activities, talk more about math, and be more highly engaged than children in the control condition.

Research Design:
Description of research design (e.g., qualitative case study, quasi-experimental design, secondary analysis, analytic essay, randomized field trial).

This was a randomized field trial in which twenty sites, 16 Public Schools and 4 Head Start centers, were randomly assigned to one of two study conditions. Thirty-one classrooms participated in the new math curriculum while twenty-six classrooms conducted business as usual.

Data Collection and Analysis:
Description of plan for collecting and analyzing data, including description of data.

In the randomized field trial, children's pre and post achievement was individually assessed using two math subtests and one literacy subtest from the Woodcock Johnson III and two non-standardized tests of mathematical ability developed to match the targeted math curriculum. This study focused on the two standardized math measures only.

Observations of child behavior were collected using the *Child Observation in Preschool* (Farran, Plummer, Kang, Bilbrey, & Shufelt, 2006), an observational tool that codes children's behavior in nine dimensions. Children were observed three times across the year for 4 hours each day. Proportions and averages were created across three time points to create the variables to be used in these analyses. The 6 behaviors examined were: the proportion of observations children were in a math focus (Math Focus), proportion of observations children were in a learning focus of any subject (Learning Focus), proportion of observations children were talking while with a math focus (Talk with Math Focus), proportion of observations children were talking while with a learning focus (Talk with Learning Focus), children's average engagement during math focus (Engagement with Math Focus), and children's average engagement while with a learning focus (Engagement with Learning Focus).

The Baron-Kenny model for analyzing mediational effects was used, which involves multiple steps (Baron & Kenny, 1986). First, the relationship between experimental condition and child achievement was examined. Because children were nested in classrooms, and classrooms were nested in schools, hierarchical linear modeling was used to predict achievement gain scores on the two math standardized measures (Applied Problems and Quantitative Concepts) from children's classroom condition, controlling for children's pre-test scores, gender, interval between testing, and age at time of testing. Second, the relationship between experimental condition and child behaviors was examined, also using hierarchical designs. Third, the relationship between child behaviors and child achievement was analyzed, controlling for curriculum condition and other covariates, again using hierarchical procedures, and the main effect of condition was examined. Models were run separately for each achievement measure and each child behavior.

Findings/Results:
Description of main findings with specific details.

Results from the analyses can be seen in Tables 1- 4 in Appendix B. Analyses revealed that significant variation in children's gains on both standardized math measures was explained by curriculum, with higher scores seen in the treatment condition (Table 1). Also, significant variation in the proportion of observations that children were focused on math activities and the proportion of observations that children were observed talking with a math focus was explained

by curriculum, with more math focus and talk about math seen in the treatment condition (Table 2). Additionally, significant variation in children's gains on both standardized math measures was explained by children's time observed in learning-focused and math-focused activities (Table 3). Finally, the main effects of curriculum condition in these last models were examined. Those behaviors for which curriculum was a significant predictor in Table 2 but was no longer significant in Table 4 were deemed to fit the mediational model. The model held for the proportion of observations children were seen engaging in math-focused activities. Children in *Building Blocks* classrooms were observed in math-focused activities more than children in the control classrooms and, in turn, made greater gains on both standardized math achievement measures. The model did not hold true for the other behavior variables involving engagement and talk about learning/math. Because of the nature of the study, numerous models were analyzed. This multiplicity in analyses can lead to Type 1 error. To correct for this, a Benjamini-Hochberg procedure was used to create a more conservative estimate of the significance of any found effects. After this correction was used, the mediational model still held true for the behavior of math focus.

Conclusions:

Description of conclusions and recommendations of author(s) based on findings and over study. (To support the theme of 2009 conference, authors are asked to describe how their conclusions and recommendations might inform one or more of the above noted decisions—curriculum, teaching and teaching quality, school organization, and education policy.)

Controlling for students entering skills and other demographic characteristics, we found that children's gains in math skills were related to the experimental condition of their classroom as mediated by their learning-related observed classroom behaviors. The *Building Blocks* curriculum, designed to facilitate children's engagement in math and talk about math, was predictive of children's participation in math-focused activities, which predicted higher gains on standardized math measures. Without the resulting change in children's behaviors in the classroom, however, changes in achievement would not have been possible through curriculum implementation alone. Although getting children to talk more about math was a goal of the curriculum, children's talk with a math focus did not predict their gain. It is possible that teachers in the treatment condition actually spent more time in learning related activities, but spent that time instructing rather than probing children's thinking or asking higher-order inferential questions. The results of this study demonstrate the difficult task of helping teachers promote an environment where children can investigate mathematics through talk and play, rather than through direct instruction. The results suggest that classrooms organized to keep children focused in learning activities will better equip children with math-readiness skills, and thereby improve early math education in large-scale public programs for children from low-income households.

Appendixes

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Appendix A. References

References are to be in APA format. (See APA style examples at the end of the document.)

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Appendix B. Tables and Figures
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Table 1

Effects of Curriculum Condition on Child Math Outcomes

Outcome	*F*	*df*	*p*
WJ Applied Problems	4.05	11.80	.068*
WJ Quantitative Concepts	5.76	16.89	.028*

*$p < .10$

Table 2

Effects of Curriculum Condition on Observed Child Behaviors

Behavior	*F*	*df*	*p*
Learning Focus	1.70	12.94	.215
Math Focus	11.43	18.51	.003*
Talking with Learning Focus	1.76	56.16	.191
Talking with Math Focus	4.87	16.00	.042*
Engagement with Learning Focus & Condition	1.86	9.55	.203
Engagement with Math Focus & Condition	2.21	17.78	.155

*$p < .10$

Table 3

Main Effects of Observational Predictors on Standardized Math Assessments

Source	*F*	*df*	*p*
Woodcock Johnson Applied Problems			
Learning Focus	2.81	166.40	.096*
Math Focus	25.79	75.58	.000*
Talking with Learning Focus	0.00	538.98	.978
Talking with Math Focus	6.86	509.61	.009*
Engagement with Learning Focus	0.63	492.01	.428
Engagement with Math Focus	2.86	529.99	.091*
Woodcock Johnson Quantitative Concepts			
Learning Focus	5.38	232.15	.021*
Math Focus	25.07	156.23	.000*
Talking with Learning Focus	2.10	551.97	.148
Talking with Math Focus	1.00	552.66	.318
Engagement with Learning Focus	0.60	531.59	.440
Engagement with Math Focus	0.59	529.01	.442

*$p < .10$

Table 4

Main Effects of Condition on Standardized Math Assessments

Source	*F*	*df*	*p*
Woodcock Johnson Applied Problems			
Learning Focus	3.65	10.61	.083*
Math Focus	0.07	6.46	.798
Talking with Learning Focus	4.01	11.79	.069*
Talking with Math Focus	3.09	11.13	.106
Engagement with Learning Focus	3.90	11.56	.073*
Engagement with Math Focus	5.57	10.40	.039*
Woodcock Johnson Quantitative Concepts			
Learning Focus	5.20	16.44	.036*
Math Focus	1.53	13.98	.236
Talking with Learning Focus	6.20	17.01	.023*
Talking with Math Focus	5.56	16.43	.031*
Engagement with Learning Focus	5.64	16.82	.030*
Engagement with Math Focus	6.55	16.63	.021*

*$p < .10$